# Synchronizing International Service Learning with ABET Outcomes

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**Abstract** – The international service learning experience for engineers at The University of Alabama engages students in leadership and teaming roles on service projects for academic credit in remote Peruvian Amazon villages. During this experience students practice some of the skills necessary for the challenges of engineering in a globalizing profession and demonstrate accreditation learning outcomes not easily taught in traditional classrooms. The service part of the course has involved the planning and installation of a range of projects in five remote Amazonian villages. Students live and work with villagers on installations in accordance with the Engineers Without Borders™ model. Students on the trips also participate in a formal post-trip assessment. They score elements of the experience using the five-level Likert scale to evaluate 12 course elements that include ABET outcomes. In addition, the students are asked four open-ended questions that allow for both qualitative assessments and additional comments. Among the outcomes that serve as an assessment basis for engineering accreditation, students agreed strongly that it was an effective learning experience with regard to communication, learning outside the classroom, teaming, and assessment of societal impacts. They agreed, but not as strongly, that it was a valuable learning experience regarding leadership. The student assessment is consistent with feedback the instructors have received following similar service learning trips. Learning outside the classroom box is the real deal and teaching outside that box has similar rewards for faculty.

Keywords: ABET, Service Learning, International Education, Outcomes.

## BACKGROUND

Data from the Institute of International Education points reveals that students studying engineering are among the least likely to participate in international educational experiences during their college career [IIE, 1]. However the rapid globalization of the economy has resulted in dramatic changes in the engineering profession, influencing the manner in which products are invented, designed, and manufactured [Polanski, 2]. The synchronization of engineering education outcomes with the profession's evolution is critical if graduates are to be successful on a global stage.

Discussing these global issues in the classroom can be a first step, but through service learning, that knowledge is illuminated and firmly instilled in the students to make for a richer learning experience. As students prepare for their future occupations, they need to be prepared for the real-world constraints and over-reaching effects of their actions. In the Hurricane Katrina Recovery Team Project at Rowan University, they found that students can become "detached from the outside world as they engage in academic activities." However, service learning "challenges traditional ways of teaching by replacing detachment with connectedness. Service learning is a way to tie academic lessons with a needed service" [Finger, 3].

Service learning in engineering is a growing field, and the EPICS project at Purdue University is a successful program that continues to exhibit the invaluable lessons afforded by service learning. With EPICS, they too, have

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found that students see the level of "connectedness" and fully appreciate the multi-faceted relationships engineers navigate. Students "understand the connections between their technical projects and the community issues they are helping to address" [Coyle, 4].

Updated standards for engineering degree programs reflect this need by expanding the traditional toolbox of engineering technical skills to include soft-skill proficiencies. Specifically, "an ability to function on multidisciplinary teams … design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, and sustainability … and the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context" are current Accreditation Board for Engineering and Technology (ABET) 2000 outcome criteria [ABET, 5].

It is a difficult challenge to implement these soft-skill experiences in a meaningful way in the classroom in a curriculum that is already full. The international engineering service learning experience provides an excellent opportunity to develop these skills and prepare students for the challenges of modern engineering.

**International Service Learning Benefits**

International service learning can have a profound effect on students, faculty, and those with whom they collaborate, with spillover effects for faculty recruiters, advisers, peers, and their home institutions. Furthermore a proportionally higher number of women and honors students participate in service engagement than are represented in the general engineering student body.

The benefits of global experiences for students include development of leadership, teaming, management, communication, and cross-cultural skills; flexibility, adaptability, maturity, independence, and the ability to analyze, adjust to, and appreciate local customs and cultural contexts; the acquisition of a global perspective, appreciation of the societal implication of their work, and the satisfaction of working with a client to take an international community project from conception and planning through installation. Experience abroad forces students to deal constructively with cultural differences and situations they would not otherwise face. At Purdue University, the EPICS program has produced such results and their studies reflect convincingly positive effects on participating students. They summarize: "EPICS students thus learn many valuable lessons in citizenship, including the role of community service in our society; the significant impact that their engineering skills can have on their community; and that assisting others leads to their own substantial growth as individuals, as engineers, and as citizens" [Coyle, 4].

Promoting the development of these soft skills can have far-reaching effects. As numerous studies are indicating, service learning is proving to be a valuable tool in encouraging women in the field of engineering. Some of the same aspects of engineering that traditionally attract women to the field are directly applied through service learning, i.e. "framing science in its societal context; stressing general educational goals, . .and undertaking problems with a holistic global scope" [Coyle, 4]. Another added benefit, service learning addresses many of the issues surrounding retention of engineering students [Ropers-Huilman, 6]. Students can more clearly see the connection between their classical engineering classes and real-life, current problems. Through service learning, they feel more connected and energized with an active learning approach. Subsequently, they feel invested and engaged in the engineering process and are perhaps more likely to stay in the program.

## INTERNATIONAL SERVICE LEARNING AT UA

The International Engineering Service Learning Program at The University of Alabama (UA) was established to incorporate these opportunities for growth into the student learning experience to prepare students for the challenges of the modern engineering profession. It does this by preparing students to serve as effective, engaged, and ethical professionals by promoting and supporting student engagement in meaningful service for academic credit through two UA centers, the Center for Ethics and Social Responsibility and the Center for Community-Based Partnerships. These centers provide administrative and seed-funding support to promote student engagement in service learning.

The engineering service experience in Peru was structured within the Engineers Without Borders™ model. This program integrates interdisciplinary engineering service learning with community partners, practitioner oversight, and faculty mentoring. Strong collaborations were established with Peruvian partners from Nature and Culture International and Programa de Conservation y Uso Sostensible de la Diversidad Biologica (Program for Sustainable Use and Conservation of Biological Diversity) in Iquitos, Peru. They provided logistical assistance and community liaison. In addition Universidad Particular De Iquitos (University of Iquitos), the local engineering

college, gave us access to field equipment and joined our students and faculty in field testing, surveying, group discussions, shopping for supplies for our upstream village projects, and evening social outings.

Our target communities were five remote Amazonian villages accessible only by boat from the city of Iquitos in the Amazon Jungle of Peru. Iquitos is the largest city in the world with no access by road. Student-generated service project ideas were developed from conversations with the community during an initial survey trip. This was followed up by two campus-based design projects. A capstone senior design team designed an observation tower to attract eco-tourism dollars, and an independent study technical elective student designed a primitive wastewater latrina (latrine) system. Two project installation trips to Peru followed. Projects resulting from this collaboration include soil, water percolation, and topographic surveys, a generator installation to hook up village lights, latrine installation, and most recently the installation of 18 solar panels in three villages. Successive groups are attempting to build upon the successes and failures of the previous team. Future teams will construct two rainforest observation towers in sensitive bio-diverse habitats. This is part of a wider effort to give local communities sustainable income from eco-tourism in order to prevent deforestation for subsistence agriculture.

Elements of the cross-college program include revolving leadership and multi-disciplinary teaming roles in satisfying pre-, peri-, and post-trip project deliverables. Students are required to incorporate realistic limitations such as technical, economic, sustainability, environmental, cultural, ethical, and social constraints and on-site procurement, project management, and implementation into the project scope. Reflection through daily journal entries and evening project meetings reinforced experiential learning. Course outcomes and experiences were evaluated through an end-of-trip report and assessment survey.

## ASSESSMENT OF LEARNING OUTSIDE THE TRADITIONAL CLASSROOM ENVIRONMENT

Students at the University of Alabama evaluate courses in a campus-wide Likert evaluation. This evaluation targets the traditional classroom-based course and is inappropriate for field-based service learning courses except for a two questions evaluating the overall rating of the course and instructor. In addition the Department of Civil Engineering has developed a set of learning objectives to satisfy ABET requirements for the BSCE degree (Table 1). Each outcome is labeled; “T” for technical or “P” for professional and designated a level 1-5 (in order from lowest to highest) corresponding to the first five of the six levels in the Blooms taxonomy of learning domains. Each course instructor selects outcomes and levels of achievement within each outcome appropriate to their course subject to approval by the faculty. In response to these learning objectives students develop a portfolio to demonstrate that they have achieved the designated course learning outcomes.

**Table 1 Department of Civil, Construction and Environmental Engineering ABET Learning Outcomes.**

| |
|---|
| **Outcome T1:** (Level 3) Solve problems in mathematics through differential equations, probability and statistics, calculus-based physics, general chemistry, and one additional area of science. |
| **Outcome T2:** (Level 4) Select and conduct program-relevant civil or construction engineering experiments to meet a need, and analyze and evaluate the resulting data. |
| **Outcome T3:** (Level 3) Apply relevant knowledge, techniques, skills, and modern engineering tools to identify, formulate, and solve engineering problems, including problems in at least four technical areas appropriate to civil engineering. |
| **Outcome T4:** (Level 5) Design a system or process in more than one program-relevant civil or construction engineering specialty field to meet desired needs, within realistic constraints such as economic, environmental, social, political, ethical, health and safety, constructability, and sustainability. |
| **Outcome T5:** (Level 3) Predict possible global, economic, environmental, and societal impacts of a specific, relatively constrained engineering solution. |
| **Outcome T6:** (Level 3) Function effectively as a member of a multidisciplinary team. |
| **Outcome T7:** (Level 2) Explain key aspects of at least one program-relevant area of advanced specialization. |
| **Outcome P1:** (Level 4) Analyze a situation involving multiple conflicting professional, legal, and ethical interests to determine an appropriate course of action. |
| **Outcome P2:** (Level 4) Organize and deliver effective written verbal, graphical and virtual communications. |
| **Outcome P3:** (Level 3) Demonstrate the ability to learn through independent study, without the aid of formal instruction. |
| **Outcome P4:** (Level 3) Demonstrate the ability to incorporate contemporary issues into the identification, formulation, and solution of an engineering problem. |
| **Outcome P5:** (Level 2) Explain the importance of licensure, and basic concepts in engineering management, business, public policy, and leadership. |
| **T** outcomes are technical and **P** outcomes are professional |

Twenty-six students have participated in the three Peru trips to date. Pre-2008 students completed standard University of Alabama course evaluations that were largely useless for this type of learning experience; however, the open-ended comments solicited by faculty as feedback proved insightful and useful in planning subsequent trips. Students on the 2008 solar panels installation trip to Peru participated in a formal post-trip assessment. At the completion of the course they scored elements of the experience using the five-level Likert scale to evaluate 12 course elements that included ABET outcomes. In addition, the students were asked four open-ended questions that allowed for both qualitative assessments and additional comments. The results are presented in Table 2.

**Table 2 Likert Scale Student Evaluations of Learning Outcomes**

| Specific Course Learning Outcomes | Average | Accreditation Outcomes |
|---|---|---|
| This trip was a valuable learning experience with respect to: | | |
| functioning as a member of a team. | 4.6 | ■ |
| developing leadership skills. | 4.0 | ■ |
| developing organizational and communication skills. | 5.0 | ■ |
| experiential learning without the aid of formal instruction. | 5.0 | ■ |
| examining possible/actual economic, environmental, and societal | | |
| impacts of a specific, relatively constrained engineering solution. | 4.8 | ■ |
| project management in an international setting. | 4.8 | |
| understanding the importance of stakeholder (village) input to | | |
| project planning, scheduling, and/or installation. | 4.6 | |
| professional career development. | 4.8 | |
| experiencing another culture. | 5.0 | |
| my own personal growth experiences. | 5.0 | |
| expanding my view of the developing world. | 5.0 | |
| I would recommend this trip to peers. | 5.0 | |
| **Overall Average** | 4.8 | |
| **5 strongly agree, 4 agree, 3 neutral, 2 disagree, 1 strongly disagree** | | |

The average score of 4.8 is quite high, indicating strong agreement that the course was a valuable learning experience. Among the outcomes that serve as an assessment basis for engineering accreditation, students agreed strongly that it was an effective learning experience with regard to communication, learning outside the classroom, teaming, and assessment of societal impacts. They agreed, but not as strongly, that it was a valuable learning experience regarding leadership.

**Learning Outcomes**

In the qualitative section of the survey, students were asked to identify five areas of learning not found in a traditional classroom. They were also asked about challenges, unexpected events, and personal growth. Five students provided eight responses each for a total of 40 comments.

Of these responses seven dealt with communications, particularly the challenges and successes with technical communications given limited language skills and non-technical clients. Example: “The form of communication didn’t matter as long as the ideas were able to cross the language barrier.” Five more responses dealt with cultural issues. Example: “Developing countries don’t really run on a schedule, but still manage to get things done.” Four

responses addressed positive aspects of teaming. Examples: “Being an effective supportive member of a group”. “The area in which I grew most was working as part of a team and communicating effectively.” Three more dealt with ingenuity. Examples: “I learned to look for alternative and nontraditional methods to accomplish tasks,” “How to make things work with what you have,” “About solar panels and how to install them.”

Others addressed leadership, coping, personal growth, and the value of international travel. Examples: “Helped reinforce leadership skills,” “I could make it without everyday luxuries like electricity and toilets,” “If I push myself I can do things I never imagined.” “I grew most in the knowledge of international traveling. Even though I had been overseas before, this trip was a much better experience. We were given more responsibilities…I was happy to grow in this area because of my very big interest in traveling and seeing the world.”

While the number of students evaluating their experience is low, their assessment is consistent with feedback the instructors have received over and over again following similar service learning trips. Learning outside the classroom box is the real deal, our students continually tell us. And teaching outside that box has similar rewards for faculty.

Future assessments will include a pre-trip evaluation to better measure learning outcomes. A question will also be added to solicit suggestions for future trips rather than leave this as an implied question under “other comments,” though when asked if they would recommend this trip to others, three gave it a 5 (strongly agree) one a 10 and one “5 x 1000!”

## SUMMARY

The international service learning experience at The University of Alabama engages students in leadership and teaming roles on engineering service projects in remote Peruvian Amazon villages. During this experience students practice some of the skills necessary for the challenges of engineering in a rapidly globalizing profession and demonstrate accreditation learning outcomes not easily taught in traditional classrooms. Students also get firsthand experience in what engineering is ultimately about: building things that make people’s lives better. Service learning courses can be a good way to document learning outcomes in accordance with ABET. Assessing the experience in a post-trip survey, students rated the development of teaming, communications, and experiential learning skills as particular strengths of the program. Future courses will include a more extensive evaluation tool that includes pre-trip assessments.

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